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Engineer Research and
Development Center

Topographic Engineering Center Shuttle Radar Topography Mission (SRTM) Study

Description and Background:

The Shuttle Radar Topography Mission (SRTM) is one of the most significant space surveys of earth ever undertaken, using precisely positioned radar to map its surface at intervals of 1-arc seconds (~30 meters) or three times the current most widely available detail. Over 11 days, the SRTM mission gathered enough data to produce a three-dimensional database of over 80% of the Earth's landmass (a total area of more than 47.6 million square miles) including previously nearly inaccessible, cloud covered areas. Similar Synthetic Aperture Radar (SAR) techniques were pioneered by ESA's ERS 1 and 2 satellites, which have been monitoring the entire Earth since the early '90s. SRTM is a joint project between NASA (www2.jpl.nasa.gov/srtm), the National Geospatial-Intelligence Agency (NGA), the German Aerospace Centre (DLR) and the Italian Space Agency (ASI).

Data Characteris- tics/Preliminary Findings Advantages:

Increased coverage – SRTM DTED2 (~30 meter resolution) covers 80% of the earth including perpetually cloud-covered areas along the equator and in other locations where elevation data had previously been unavailable.

Improved terrain visualization (except in smooth terrain areas) – SRTM DTED2 can be used in conjunction with controlled imagery sources to provide better visualization of the terrain and assessment of the terrain's impact on military operations.

Better support to ortho-photo rectification – NGA/St. Louis is currently using SRTM DTED2 data to ortho-rectify CIB 1 & 5 on a routine basis with excellent results.

Shortfalls:

Unusable contours - Map contour lines in smooth terrain are unusable due to random data noise that remains after final processing. Reflective surface contours can misrepresent "bare earth" characteristics.

Negative impact on line-of-sight (LOS) and slope prediction – Noise-induced anomalies create erroneous results in LOS over smooth terrain especially at the low grazing angles required for most Army operations. SRTM DTED2 predicted error tends to increase over rugged terrain and hinders slope analysis.

Void Areas – Void data areas may have significant effects on Army applications. Larger void areas (over 16 posts) will only be filled by NGA on a "customer request" bases. ~1% of global one degree cells are expected to have over 20% void areas rendering them virtually unusable.

TEC Study Background:

In 1997, a DARPA/TEC study validated the mathematical accuracy of reflective surface radar-collected digital elevation data but identified "different properties" and anomalies (void areas/contour interpretation) vs. photogrammetric source. The report recommended further study to determine if functional use of the two products will yield similar performance during operational or training use.

SRTM DTED2 is anticipated to eventually comprise the bulk of NGA's elevation data holdings and become a critical "backbone" mapping tool for the future. The increasing proliferation of data has led to the recognition that a technical evaluation of SRTM DTED2 capabilities/utility is vital to the Army geospatial user community and could steer future enhancements. In

response, Army prepared a proposal to conduct a ground-truth validation of SRTM DTED2 to determine operational effectiveness.

Methodology/Status:

- Compare to traditional DEMs/TINs
- Analyze void areas and terrain profiles/contours
- Collect ground truth LOS and slope data; use selected algorithms and terrain representations to determine sensitivity of SRTM DTED2 for M&S/C4I systems

SRTM DTED2 "finished" data is currently being received at NGA and placed on their distribution gateway; global coverage by September 2004. The Department of the Army has provided funding through the Army Study Program. Preliminary activities/analyses have commenced.

Study Activities to Date:

- Technical fact finding completed at NGA/St. Louis
- SRTM DTED2 "finished" data acquired over 6 study areas (bare earth, sparsely vegetated, vegetated) and some initial analyses completed
- Ground truth data validation activities scheduled in FY 04/05
- Point paper and preliminary analysis prepared in February/March 2004

Applied Resources, Inc. Study:

Applied Resources, Inc. has provided a proposal for a SRTM study in response to an Engineer Research and Development Center Broad Agency Announcement.

Objectives:

SRTM terrain data has not yet been thoroughly evaluated for quality and utility. For military aviation, and for military ground use, a significant benefit would accrue if data accuracy were adequate to support either type of operations. The aim of this effort is to measure the inherent capabilities and limitations of the SRTM data in terms of real-world applications and limit the potential for erroneous results in using the data. Evaluation of the accuracy of SRTM data will encompass both aviation and ground-based investigations.

1. *The Aviation Evaluation Objective* is to evaluate how well the data can assist pilots to fly aircraft safely over different types of terrain. Sub-Objectives are to:
 2. Determine how close the database matches the actual terrain.
 3. Evaluate a pilot's ability to readily avoid spiky/cliff type terrain horizontally. Also, evaluate how close a pilot can safely avoid the terrain.
 4. Measure how low pilots can safely operate over gently rolling terrain.
 5. Evaluate different displays and determine the type of display(s) that work best.

The Ground Based Evaluation Objective is to evaluate how well the data supports analysis of line-of-sight (LOS) from terrain point to terrain point.

Sub-Objectives are to:

1. Determine how closely the SRTM database matches the actual terrain in vegetated areas (i.e., determine how far the SRTM technology penetrates the canopy and where the reflective surfaces lie within the vegetation).
2. Determine how the SRTM accuracy differs with and without a canopy.
3. Determine the extent random noise in the SRTM data can be filtered out to make the data more accurate.

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